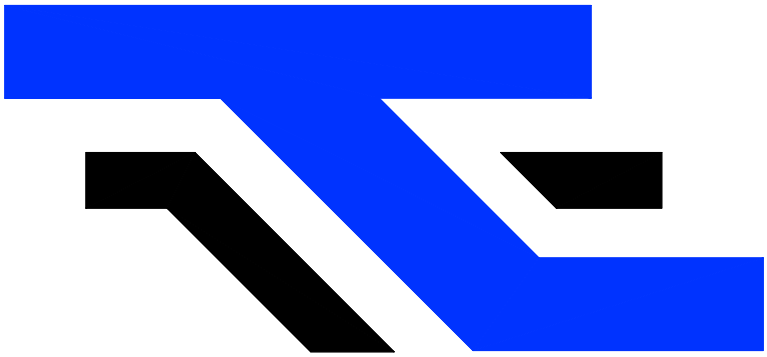

Chapter 5
Teaching Technology at the Middle School Level

MISSOURI TECHNOLOGY EDUCATION GUIDE
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Teaching Technology at the Middle School Level

1. Introduction

The material in this chapter is taken from *Teaching Technology - Middle School: Strategies for Standards-Based Instruction* (ITEA, 2000).

The mission of technology education at the middle school level is to provide students with experiences in technology. In technology education, students investigate how things work and design solutions to problems using tools, materials, and other resources. These activities help students assess their personal interests and talents and then relate them to a wide range of careers and educational opportunities.

2. Curriculum Thrust: Exploration & Engagement

Technology education programs in grades 6-8 strengthen what students learn about the processes that apply to the design, development, and use of technological products and systems. Students will have opportunities to explore and be engaged in activities that allow them to produce models and develop real technological products, systems, and environments.

The study of technology lends itself as a natural curriculum integrator with other fields of study. This advantage, along with the pleasure early adolescents take in active learning, emphasizes the need for a well-planned and developed technology education program. At the middle school level, the study of technology should be an instructional sequence that builds on experiences and knowledge developed in K-5, and it should extend the development to be a foundation for future courses at higher grade levels.

3. Suggested Course Titles and Descriptions

The following courses are recommended by the International Technology Education Association's Center to Advance the Teaching of Technology and Science (ITEA-CATTS) to be taught at the middle school level.

- *Exploring Technology*
  Students develop an understanding of the progression and scope of technology through exploratory experiences. In group and individual activities, students experience ways in which technological knowledge and processes contribute to effective designs and solutions to technological problems. This course may be six weeks or nine weeks in duration.

- *Innovation and Engineering Design*
  Innovations, or commercially produced inventions, affect us personally, socially, and economically. Students participate in engineering design activities to understand how criteria, constraints, and processes affect designs. Brainstorming, visualizing, modeling, constructing, testing, and refining designs provide skills in communicating design information and reporting results. This class is suited for 18 weeks.

- *Technological Systems*
  Students become acquainted with content and processes associated with basic technological systems. The design, development, and relationships of different systems are explored. Students apply systems concepts to design and problem-solving activities related to transportation, information, energy/power, biotechnology, and other technological systems. Laboratory activities engage students in constructing, using, and assessing technological systems. This course may be 18 weeks or 36 weeks in duration.

The following principles must be taken into account when planning and selecting methods and strategies:

4. Nature of the Learner

The currently-accepted vision of children as active, constructive thinkers who develop in the context of their social world as put forth by such theorists as Vygotsky and Mueller provide the basis for many of the methods discussed and related in this chapter. Contemporary research on the brain, multiple intelligences, and learning styles have added to the discussion and understanding of how children learn.

Middle level students are moving between childhood and early adulthood. Physical growth and change is significant as girls tend to mature earlier than boys do. They are curious and want to be a part of the adult world. They are interested in learning and are developing the ability to do things and make things as adults do. Yet, they are developing independence and each student will demonstrate his or her own learning and expression styles. Influence of peers builds during this time and the middle level student may be less likely to accept adult guidance. These students are active and thrive on social contact. The need for approval and self-worth development is high.

Using opportunities that allow students to work in teams or small groups provides them with interactions that are important for social development. Small group activities may be particularly effective in building students' self-esteem by enabling boys and girls to have success with new and perplexing tasks. Building on knowledge and abilities learned in precious grades, middle level students should be encouraged to approach technological programs without fear. It is important to realize that middle level students learn independently and out of curiosity. They should be encouraged to be in control of their own learning by refining their abilities and developing and using decision-making and critical thinking skills.

Teachers are encouraged to review works by leading developmentalists William Damon, Howard Gardner, David Henry Feldman, and Deanna Kuhn for helpful

suggestions on incorporating the current views of child development, such as multiple intelligences, creativity, and how to apply basic research in an educational setting.

5. Transforming the Middle School Education

The 1997 national report, *Turning Points: Preparing American Youth for the 21st Century*, makes the following recommendations for transforming middle schools. Technology education teachers can contribute to the improvement of their middle schools by following these recommendations:

1. Create small, personalized communities for learning.
2. Integrate content in technology education with core academic programs.
3. Ensure success for all students.
4. Be involved in pedagogical, management, and budget decisions.
5. Obtain training or continuing education for teaching young adolescents.
6. Foster health and safety
7. Re-engage families in the education of students.
8. Connect middle schools with communities.

(Adapted from Lipsitz, et. al., 1997).

6. Career and Educational Exploration

Careers and career information are topics of critical importance to the future of all students. Therefore, it is important for all students to have opportunities for career and educational exploration throughout the learning process. Career information can help students explore some of the opportunities they may choose from in the future. At the middle school level, students may make tentative career choices that in turn will enable them to select classes and educational programs that meet their aspirations. Because technology is a part of our everyday life, most careers will require students to understand and be able to use technology.

Career exploration and *career decision-making* are terms that reflect how career information is shared in many school settings, how careers are discussed, and how students learn about a variety of careers.

Career Exploration is a term used to describe the middle school experiences that enable students to get a glimpse of a variety of careers and school subjects that prepare people for those careers.

Career Decision-Making is a process by which an individual becomes aware of careers that are of interest. Decisions are made of one as one learns more about his/her own abilities, aptitudes, and interests. This process continues throughout life.

7. Changing Emphasis in Technology Education

The chart below provides a guide on the change in *emphasis* in the study of technology and how this may be implemented in the technology education laboratory-

classroom. It is not to imply that those topics listed on the *Les Emphasis* side should no longer be discussed or taught. It means that there should be less emphasis placed on them in order to provide for the recommendations listed on the *More Emphasi*s side.

Changing Emphasis in Technology Education	
Less Emphasis On:	*More Emphasis On:*
Knowing technical details and parts of tools	Understanding systems and their interrelated parts
Activities that are fun	Selecting fun activities that reinforce and teach content
Processes and skills to complete a project	Designing and planning before making
Working alone	Working in groups or teams
Teacher as information expert	Teacher as facilitator of student learning
Management of materials and equipment	Management of ideas and information
Student communicates to teacher	Student presents information to classes
Tests as the only assessment	Self and team evaluation and reflection
Right or wrong answers	Open-ended, innovative, creative solutions that allow for opportunities to take risks and discover what works

8. Documenting Student Achievement of Content Standards across Grade Levels

In order to completely address students' technological literacy and effectively document their achievement, teachers will have to articulate the *Standards for Technological Literacy* with their curriculum. They will need to develop activities beyond those presented in the next chapter in a way that will allow their students to address all twenty standards and their related benchmarks.

While this curriculum development process will be time consuming, it will not be as difficult as documenting student achievement across the standards from year to year.

While using portfolios is an obvious long-term solution, a matrix can be used to document that a particular benchmark has been addressed. The teacher passes the checklist to the student's next teacher as the student matriculates through the school system. This process will be most easily accomplished with a computer database.

For more information on transforming the learning environment, see Lipsitz, Jackson, and Austin (1997). For more information on how students learn see Damon (1991); and Holt (1983).

9. Methods: Strategies for Standards-based Instruction

This section contains several methods for teaching middle level students. Since students at this age level have unique developmental needs, the technology education teacher should choose and adapt these activities according to their teaching styles and students' learning styles.

Method 1 – Using Design Briefs to Challenge Problem Solvers

The importance of problem solving cannot be overemphasized. Students need to be problem solvers at every age, both in school and at home. Teachers may use design briefs to challenge and encourage students to think, create, and solve technological problems. When students first begin using design briefs, short paragraphs should be used to engage them in creative problem solving. As students become accustomed to using simples design briefs, more complex and detailed design briefs that do not have one right answer should be developed to challenge them to be more creative and to use higher-level thinking and problem-solving skills. Also, as students become more advanced in suing design briefs, they should be challenges to develop and write their own.

Definitions

Design Brief: A written plan that identifies the problem to be solved. It is used to help students think of all aspects of the problem before starting to work on improving and/or developing a way of doing something. The design brief describes the problem, identifies the criteria, and lists the constraints students will face in creating a solution.

Constraint: Side effect or limit within the design process.

Criterion: The desired element or feature of a product or system.

Problem Solving: The logical process of using prior knowledge, asking questions, testing and trying ideas in order to solve a problem, to meet a need or want, or to improve a process or product.

Design Process: A problem-solving strategy, with criteria and constraints, used to develop many possible solutions to solve a problem or satisfy human needs and wants. The design process is a general developmental method that is iterative (not linear).

Getting Students Started with Design Briefs

1. Select or write short problem statements (design briefs) that incorporate a concept being discussed in the class. Many well-written design briefs may be found in *The Technology Teacher*, text-books, and instructional materials. However, it will also be necessary for you to write your own for a specific purpose.

Content Examples:

- Selecting and using appropriate tools and materials for a given purpose.
- Working together in pairs or groups.
- Using sketches, schematics, and models to communicate.
- Developing safe ways to transform organic and inorganic wastes into usable resources.
- Designing a product or system to meet a need or want or to solve a problem.

- Using symbols, logos, or language to communicate.

2. Give a previously prepared design brief to each group or use a transparency, computer presentation software, or blackboard to display it.
3. Discuss with students the definitions of constraint and criterion and why constraints and criteria are identified. Help them determine how constraints and criteria affect a design brief.
4. Provide the specified materials, supplies, or tools needed to complete the challenge in the design brief. Remind students of the limitations in using resources stated in the design brief.
5. Have students work together in order to create and develop solutions to the problem statement.
6. To aid students in developing their creative-thinking and problem-solving skills, illustrate the many steps they may follow in the design process. Remind students the steps are iterative and, therefore, do not have to be followed in any particular order and each step may be repeated as many times as needed.

General Steps in the Design Process:

- Describe the problem and learn more about it. Specify goals.
- Generate ideas to solve the problem or meet a need or want.
- Identify criteria and constraints.
- Consider alternatives.
- Select one idea.
- Plan, prototype, model, and develop the idea.
- Test and evaluate the product or system.
- Make adjustments and revisions if necessary.
- Communicate solution and design process with others.

7. After completing this activity, ask each group to explain their solution(s), demonstrate their solution(s), evaluate their solution(s), and discuss the procedures they used in solving the design brief.

Sample Design Brief Statements

These short design brief statements may be adapted and used to motivate students.

1. Using any item(s) that you would normally dispose of, create an object that would be useful around your home. Work by yourself or with one other person in this class. Be prepared to discuss your object with you classmates.
2. In groups of three or four, design a fixed-route transportation system that will transport goods (clothespins) between two points in the laboratory-classroom. Use only the materials in the bag that you are given. You may only use your hands to touch the system before the goods have departed and after they have arrived at the destination. Test your system in order to evaluate the results of your design and, if necessary, to revise or fix it to work better.
3. Using a flashlight, cardboard, tape and fasteners, develop a signaling device for sending messages across the laboratory-classroom. The device must be able to turn the light beam into coded information that can be read by another student who is not in your group.

4. Using materials provided by the teacher, design and construct a catapult that will transport a large marshmallow a specified distance. Teams of two or three students will work together to make one catapult. Explain how your device works, demonstrate its use, and record distance achieved.

Components of a Design Brief

Context or Situation: This part of a design brief describes a real-life situation where a problem occurs or where a want or need can be met. The context may be from broad areas of student life, such as school, community, home, or world. Other practical situations may be selected from student involvement in athletics, transportation, recreation, family, or fitness.

Need or Challenge: The challenge statement gives a clear focus to the design problem. It explains to the student how the needs of a situation may be met with out describing how to solve the problem.

Objectives: The objectives of a design brief are selected by the teacher. In most cases, the objectives come directly from *Standards for Teachnological Literacy* and the curriculum. The objectives may be modified by the teacher to meet the individual needs of a group or individual students.

Criteria: The criteria relate to the overall desired goals of the design brief and should be measurable objectives that can be attainable in a reasonable time. Together with constraints of a problem, criteria can be written into a design brief as a section called Requirements.

Constraints: The limitations that are imposed on problem solving or designing. The limitations may be caused by availability of specific equipment, such as computers, space, materials, and human capabilities. Together with the criteria of a problem, constraints can be written into a design brief as a section called Requirements.

Resources: The things needed to get a job done. In a technological system, the basic resources are: energy, capital, information, tools and machines, materials, people, and time.

Evaluation or Testing: Evaluation or testing is an important part of the problem-solving and design process. The evaluation statement provides the guidelines to help students determine if their solution solves the problem and meets the criteria of the design brief.

Assessment: Teachers may use the assessment to indicate how students will be assessed on what they have learned through the completion of the project. Criteria for assessment is based on the Standards that relate directly back to the objectives of the lesson selected by the teacher.

Helping Students Write Design Briefs

1. Students should be encouraged to write their own design briefs to guide them in solving problems they selected.
2. Encourage students to do research or read about the topic before writing the specifications for the problem in the design brief.
3. Provide a handout that depicts the components of a design brief or have students refer to earlier samples.
4. Assist students with writing and selecting appropriate objectives, constraints, criteria, and assessment statements.

Method 2 – Teaching Students to Assess the Impact of Technology

Overview

All around us, we are aware of things that do not turn out the way they should. Why did the new business close after only a few months of operation? Was it because of poor planning? Why is the local chemical company polluting the river system? Why is the number of traffic fatalities on our roads continuing to rise? In order to find the answer to these and other similar questions, assessment techniques must be used. Assessment is a critical part of the study of technology, and therefore is both a method and content.

Definition

Technological Assessment: A process of evaluating new technological items to predict the good and bad effects that may result. This process of thinking will lead to the identification of second, third, and fourth effects that may affect society more deeply than the primary effects. Using technological assessment leads to socially responsible decision-making.

Impact of Technology: The results of technological change. These outcomes may affect our society in economic, cultural, social, political, environmental, or a combination of many of these ways. The impact of technology can be observed in history, identified in the present day, and predicted for the future.

Science, Technology, and Society: This technique allows students to take an interdisciplinary approach when examining the concepts and processes of science and technology and relating the effects of each on society. This study helps lead to an informed citizenry capable of making responsible and social decisions.

Getting Started

At the middle level, it works best to have students find examples of technology around their home or community that illustrate the desired and undesired effects of technological development. You can have your students cut articles and pictures from the newspaper, do research in the libraries, or find information on the World Wide Web. Students can then share their information with their classmates and explain how the technological development impacted the environment, society, culture, economy, or various other factors.

Students may report their findings in portfolio presentations, descriptive reports, multimedia presentations, or oral presentations. They should be guided to ask themselves questions that foster thinking about the product or system, its stated purpose, and its actual impact. Asking the right questions is an art that develops over time and with numerous opportunities to explore and acquire new information. When you use this method of instruction for the first time, help students prepare a list of questions that will help them understand and to begin to guide their own thinking. In addition, provide plenty of time for students to discuss their questions and allow students to prepare or give thoughtful answers. Have students make a written record of their considerations, observations, responses, and conclusions.

The following sample questions will help guide you as you incorporate this method into helping students understand more about the nature of technology through assessment.

- What is the product or system? What can you tell me about it?
- How is the product or system used? Is its current use what it was originally intended for?
- Where can you find needed information about the products or systems, individuals, society, and the environment? Does it have potential harm if misused, not maintained, or ignored?
- What would happen if the product or system were no longer available or was worn out?
- What is the product's or system's strengths and weaknesses? How has it helped individuals in society, or the environment?
- Is the product or system necessary?
- Is the product or system designed to aid all users, or must special adjustments be made to help someone who may have a disability or handicap? If adjustments must be made, would making the adjustments cause unexpected hardships or unintended misuse? If so, would a new design need to be made in order to address the issue more effectively?
- How many kinds of technological processes are used in order to develop this product or system?
- Should the product or system be made just because it can be made? What is the economic impact of the product or system if it is made or is not made?

Students may want to expand on their presentations. One way is by showing how they can predict the long-term results of a technological development prior to making and selling a new product. This assessment can be accomplished through mathematical measurement and scientific reasoning. This requires students understanding data collection, statistical questioning, and how to draw conclusions.

Providing students with opportunities to discuss their findings, determine the value and importance of a product or system, and draw conclusions on their discussions will aid them as they begin to learn that assessment is an on-going process that takes many different forms at varied levels of difficulty. By teaching students these assessment techniques, they will one day have the skills to be responsible decision-makers in deciding what products, systems, and technologies are introduced or modified for future use.

Basic Steps for Assessment

1. Describe the technological development they will assess and begin learning more about it.
2. Generate or brainstorm possible impacts, both positive and negative, of using this product or system. This should include social, economic, and environmental effects.
3. Analyze the above list and identify options to deal with or avoid the problem.

4. Make predictions based on the alternatives.
5. Communicate the benefits of the technological assessment.

Method 3 – Cooperative Learning, Teamwork, and Leadership

Overview

Group work or teamwork is an effective strategy for helping students learn more about technology and to accomplish the objectives of a lesson while at the same time, they learn the importance of working together in order to reach a common goal. Students will gain more knowledge and skills working together than they will working individually. Providing students with numerous opportunities to work together will help them increase their communication skills, organizational processes, and confidence in working with others.

When cooperative learning is first introduced into the laboratory-classroom environment, sometimes confusion occurs between teacher and students about what is expected when working in groups. Cooperative learning is more than simply sitting in a group and solving a problem in the least amount of time or allowing one person to do all of the work while the others sit back and watch. Cooperative learning is the interaction of students through discussing the information or problem being investigated. This means that students should not only actively discuss ideas, but also help and share solutions so that all students should be instructed on how to help each other through positive promotion of each individual's capabilities. Encouraging all students to excel will help students realize their own strengths and begin to build upon them.

As important as learning to work together is viewed in schools today, learning to self-assess how well students work together is essential to developing skills that will help them in future endeavors. Students need to determine how effectively they work together and if they are using appropriate interpersonal skills. Asking questions of themselves as they are working together will help them guide their own thinking and make adjustments when situations arise in different environments. Most importantly, students will learn to hold themselves, as well as their peers, accountable for their share of the work and realize that together they can all learn.

Definitions

Cooperative Learning: This type of learning is based on the notion that students can learn from each other by coordinating efforts in a format that promotes the exchange of dialogue and ideas. Each member of the small learning group has a role or responsibility to share and contribute to the other members' and the groups' progress.

Teamwork: This process helps students work and learn together. Small groups or teams encourage students to share knowledge and skills while completing both short and long assignments. This is similar to the professional world, such as a project team consisting of engineers who bring different expertise to the group.

Leadership: This ability enables people to influence others. Leading in a group involves planning, organizing, communication, managing, and cooperating.

Getting Started
1. Discuss the benefits of working cooperatively. Describe organizations with leaders and followers. Discuss the attributes of an effective leader and cooperative participants.
2. Arrange students into small groups of three or four students based on the type of activity and the type of students needed in the group.
3. Have each group select a leader and recorder and assign related jobs for the remaining members. Remind students that each member will have a specific job, but all members are responsible for the group results.
4. When time permits, have teams prepare a team name, logo, and slogan as a way to learn cooperation and show group identity.
5. Hand out design briefs or assignments to each group and encourage students to read and discuss the challenge.
6. Provide guidance to the group by prompting with questions without giving answers. Provide time to mingle with the groups and quietly observe that each member of a group is participating in the dialogue and that the work is not being dominated by only a few members.
7. Throughout the year, rotate groups in order to improve group dynamics, increase learning, and develop new leadership.

Student Rules and Expectations
- Stay with your team and cooperate.
- Everyone must participate, share, and speak up.
- Respect others, yourself, teacher, and materials.
- Elect leaders to fill specific roles and responsibilities.
- Manage time, resources, and people carefully.
- Speak or report on the progress of your group.

Method 4 – Assisting Students with Special Needs

Overview
There are a variety of techniques that teachers can use to help students with special needs function successfully in technology education classes. With proper laboratory-classroom facilities and well-trained teacher, students with special needs can become active and successful participants in technology education classes.

Definitions
Learning Disability: A disorder in one or more of the basic psychological processes involved in the understanding or use of spoken or written language, which may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations. Causes may be perceptual handicaps, brain injury, brain dysfunction, dyslexia, and developmental aphasia.
Emotionally Disturbed: A type of disorder where observed behaviors deviate from the average or typical. Students with emotional or behavioral disabilities exhibit undesirable actions or feelings over along period of time which adversely affects performance. Symptoms include an inability to get along with their peers as well as hyperactivity. Also known as behavior disorder.

Mental Disorder: Disorders marked by social deviance, personality disturbances, and emotional turmoil.

Involvement in Individualized Education Program Planning

In 1975, the Education for All Handicapped Children Act (PL 94-142) was passed by Congress to provide all children with a free and appropriate education. One of the main provisions of the Public Law 94-142 was the introduction of the individualized education program or plan (IEP) for each special needs student. An IEP allows parents, teachers and students to plan the best individualized instruction in order to meet the specific needs of the student. The plan typically explains special services that are required for the student to help him or her meet the requirements of the course. For example, if a student has a reading deficiency, accommodations for taking tests may be provided, such as tests that are not timed or providing a test-reader who will read the test to the student who then respond to the question on their paper.

The IEP has proven successful in many school districts. Some school districts are considering or have implemented the use of IEP for all students, not just those with documented special needs. The IEP process alerts the teacher to the student's present level of educational performance and goals or services that need to be provided. Teachers can use the IEP as a guide to learn how to modify their laboratory-classroom and teaching styles in order to meet the needs of all of their students.

Techniques for Diverse Learning Styles

- Use both visual and verbal teaching techniques.
- Make lessons concrete with models, handouts, and sample artifacts.
- Give immediate feedback for performance to reinforce appropriate behavior.
- Offer individualized instruction and group or peer assistance.
- Organize activities to ensure successful learning and projects. Keep steps simple.
- Challenge students to their optimal level.
- Repeat important concepts.
- Collaborate with special education teachers in subject matter and instructional procedures.
- Facilitate the participation of all students in group, class, and club activities so they perceive themselves as part of the team.
- Include both technical and career information as part of laboratory activities.

Method 5 – Enhancing Creative Thinking

Overview

Everyone needs great ideas. Whether they come from a teacher, parent, professional, or student, creative ideas lead to success. Ideas come when a person with a creative mind is concerned about a problem, situation, crisis, or goal. Creation is fun because it is play. It allows a person to manipulate objects and ideas in order to come up with something new.

Learning to be creative takes time and there is no quick, simple technique. An environment that allows students to freely express their emotions, thoughts, and ideas is

central to the development of creative thinking. Also, students must be provided with the needed feedback that it is okay to express their feelings, to try out new ideas, and to experiment, test, or explore. Teachers need to recognize when they should step in and provide more leadership and structure to the laboratory-classroom environment. Proper guidance, when necessary, helps students get started on a creative activity, get unstuck, or have confidence in their decisions. This encouragement will then enable students to be willing to try out their ideas and to solve challenging problems without the fear of failure.

It is vital to help students understand that the failure of an idea is not the end, but the beginning for many new discoveries. This concept is essential for them to be willing to work on a problem until they are able to solve it or to realize the solution may not be available with the information that is presently available. One way to reinforce this concept is to share with students how inventors of the past are often quoted about their failures. Students should also begin to realize that it is not how fast they are able to solve a problem or develop a solution that is important, rather it is that they are learning the process of creative thinking. It is important to stress to students that when a failure occurs, it is not that the idea was bad, rather, it is a chance to learn what does not work and perhaps open the door to a better idea.

Encouragement, freedom of expression, curiosity, exploration, questioning, daydreaming, and appreciation for what is tried all bring out the natural creative expressions for many students. In addition to a creative, friendly environment, students still need structure and clarity of purpose. Therefore, it is important to state clear expectations – rules, deadlines, and feedback. Allowing students to help set the expectations provides them with a feeling of ownership and the confidence that the teacher and the environment promote creative thinking.

Definitions

Invention: The creation of a completely new idea, device, or different way of doing something.

Innovation: The improvement of an existing idea, device, or way of doing something in a creative or different way.

Creativity: The ability to look at the same thing as everyone else but to see it differently.

Creating an Idea-Friendly Laboratory-Classroom

- Allow students the inner freedom to consider new ideas and possibilities. Take away the obstacles that prevent students from having the freedom to be creative and to dream.
- Establish a creative laboratory-classroom environment where students are encouraged to think differently and create new solutions. For example, you can provide tables for group planning and brainstorming and signs and posters that encourage creativity. You can also frequently rotate students into new groups and topics to encourage the flowing of new ideas.
- Before students can begin to solve a problem, he or she must know what the problem is. You can clarify the problem by writing down words or descriptors of

the problems. Some words will trigger other words about the problem until students create an idea map, cluster, or outline that clearly defines the problem.

- Teach students the art of brainstorming. Use it frequently as a way to involve the entire class in a discussion or as a tool for small groups to use as a way to think up creative ideas.
- Avoid or diffuse phrases that kill creativity. "Killer phrases" that students may utter, such as "I can't do this," "This looks stupid," and "I can't believe that is your solution," may come from self-doubt or the fear of looking stupid. Other phrases may come from classmates who want to criticize their peers. These comments must be immediately recognized, corrected, and perhaps redirected into new ideas so that students will not be afraid to share their ideas with the group.
- Illustrate creative thinking using various methods, such as envisioning the problem to be solved, thinking in opposite directions, or offering a statement that compares one problem to another.
- After students have spent time brainstorming, evaluate the ideas. Describe the positive, interesting, and negative factors of each one. Allow new ideas to flow from this exercise.
- Remind students that the best way to develop great ideas is to look at lots of other people's ideas and then evaluate them.

Method 6-Sharing, Reporting, and Recording Information

Overview

An effective method teachers may use to assess students' performances is to have the students talk about or share information about their model, project, or solution. Design portfolios or logs are used to record ideas and steps in the problem-solving process and to provide a means to share what they are learning with others. This method may be used on a regular basis as a means to provide students with the opportunity to gain confidence and to learn how to effectively communicate and how to make presentations.

Definitions

Sharing: Students give short talks about what they are learning about or doing in class. They may offer advice to other students during formal seminars or as a part of teamwork and cooperative learning.

Oral Presentation: Takes place at the completion of an individual or group project. This report may include the use of visuals, such as illustrations, photographs, computer-generated images, models, posters, flip charts, or slides.

Portfolio: A systematic and organized collection of a student's work that includes results of research, successful and less successful ideas, notes on procedures, and data collected. The design portfolio or design log may also be used to demonstrate the cumulative learning process of a student over a unit of study, grading period, or entire course of study.

Getting Started

- Call on students to tell the class what they are making or to describe significant progress they have made or something they have learned.

- Arrange progress seminars where each student (or group) gives an oral report on progress, problems, and recent achievements.
- Make suggestions and offer assistance during progress achievements.
- Give an outline to students in order to guide them in preparing an oral report or presentation. The outline may include these components:
    - Introduce your team and topic.
    - Describe your task.
    - Present results using illustrations.
    - Share problems or challenges faced during activity.
    - Make concluding remarks or persuasive comments.
- Encourage the use of note cards, posters, flip charts, slides, or multimedia equipment.
- Help students assess their own delivery skills (e.g., Am I speaking slowly? clearly? and loudly?)
- Invite guests from the community, other teachers, or parents to attend presentations to give students practice in speaking before diverse audiences.
- Register students for events as part of the Technology Student Association (TSA), or other co-curricular organizations such as:
    - Challenging Technological Issues
    - Construction Challenge
    - Prepared Speech
    - Technical Writing Challenge

Recording Student Progress in Portfolios or Logs

1. Introduce students to the importance of keeping or documenting their ideas and progress while designing and completing engineering and invention activities.
2. Provide examples of design portfolios or logs from previous students, engineers, and architects. Provide or suggest the page format. Encourage them to use three-ring notebooks, folders, or computer files to keep their work organized. For an example, see *Teaching Students About the Impact of Technology*..
3. Encourage students to design a logo and title for their team project and use it on the cover and throughout the portfolio or log.
4. Provide lessons in illustration using felt tip pens, computer software, and CAD modeling in order for students to include representations of final designs in their portfolios or logs.
5. Pose questions or writing prompts to students and ask them to reflect on different aspects of their learning. Ask students to explain their understanding of the topic being discussed and to express concerns, thoughts, or ideas. Questions or writing prompts that may be used to help students start writing are:

- Develop a calendar outlining work to be done.
- Make a list of work completed during the time period.
- Report about a person known to have contributed to technological developments.
- Use diagrams to represent understanding of a topic.
- How would you explain your topic to a student who didn't understand?

6. Review the portfolios or logs on a regular basis to ensure that students keep them current with steps and progress made.
7. Evaluate each portfolio in relation to the solution of the project and the actual learning achieved by students.
8. Display and share the completed portfolios with other students, teachers, parents, and the public. Have students use their theme in their oral presentations and events, such as TSA competitions and science fairs.

Contents for Design Portfolio or Log

1. Title page, logo, and student's or group's name
2. Table of contents
3. A letter from the student explaining his or her learning and growth
4. Problem statements or design briefs
5. Ideas (all illustrations and sketches produced at each stage)
6. Observations from investigations and actual data collected
7. Testing or evaluation of solutions
8. Final solutions and recommendations
9. Reflections and responses to questions, concerns, thoughts, ideas

Format Resources

Magazines, textbooks, and technology education activity guides contain various formats for design portfolios and design logos. (See Chapter 3, Section B.)

Method 7-Using Simulations to Teach Technology

Overview

Simulations enable students to relate what they are learning in class to real-life situations. This exciting method of instruction allows students to learn by doing or by acting. The students go from observers to being actual participants. Typically, simulations or gaming takes place in groups and involves models of larger or smaller objects or games involving situations with risks and rewards.

Definitions

Simulation: This teaching strategy engages students in roles that are similar to real life. The students will learn how to apply the concepts learned in class, such as expressing their views and making decisions, to these real-life situations.

Gaming: Gaming refers to the less realistic activities in which students are presented with a situation involving choices, risks, and pay-offs. Much is learned as students enjoy the challenge or the chance to play to win.

Benefits of Using Simulations

Simulations add reality and excitement to learning. Students are motivated to learn and react to the problems presented, because they realize that other people will be affected. Higher motivation results in higher learning.

Samples of Simulations

- "Challenger Learning Centers" engage students in a space shuttle mission in which students use problem solving, creativity and critical-thinking skills. Mathematics, science, and technology content is learned by students working in teams and communicating to achieve a common goal.
- Enterprise or mass production simulations engage students in experiencing and simulating a manufacturing plant.
- Museum exhibits provide opportunities for students to simulate a large or complex system.
- Models may be made to simulate larger or small devices.
- Computer simulations enable students to simulate activities of large-scale enterprises, such as cities, governments, and other such systems.
- Conducting meetings with representatives from the board of directors, managers, stockholders, and other groups provide students with opportunities to simulate operations that are typical in the business world.

Method 8-Using Concept Maps ™ to Facilitate Learning

Overview

In the early 1970's, Joseph Novak and a team of graduate students developed concept maps as a tool to engage students and as a way to encourage them to think about their learning. "As an alternative to typical testing, concept mapping is proving to be a powerful tool for evaluation, and this, together with other new evaluation methods that are beginning to emerge, show promise both for educational research and practice." (Novak, 1998, p.17). Concept maps are visual pictures of how students think, and they make connections of their ideas and meaning out of their thoughts.

Concept mapping is a method that will enable teachers to guide students as they learn the concepts and principles of technology. Often students acquire new terminology, ideas, rules, procedures, and strategies, but do not know how they are linked together or how they may help them in their learning. Through instructions on how to develop a concept map, students are able to make those connections as well as make adjustments in their thinking as new experiences allow new information to be added.

Teachers may use concept maps to determine what students already know about a topic or concept, how previous learning is retained, and what areas need reinforcement. These maps can be used to show teachers what instruction needs to be given to address new information and help provide students with a means to make connections with their prior knowledge. The use of concept mapping helps students to answer the question "How is this going to help me?"

After students have created their concept maps, teachers should follow with activities or other instruction that will enable students to build on their knowledge, explore new ways of looking at relationships, and have meaningful discussions that will help address student confusion or enhance their understanding.

There are various means through which students may develop their concept maps, from using simple pencil drawings on paper to the more elaborate use of computer software specifically designed to construct concept maps.

Definitions

Concept map: A map depicting the hierarchical order of key concept words and propositions. The map is designed with a key word or question at the top, and then related words, phrases, and ideas are linked with arrows and lines depicting relationships and connections. The linkages also have phrases that show the relationship.

Concept: A broad category of information that has distinguishing features that are commonly held.

Getting Started

When students are first learning how to make concept maps, it is best to begin by giving them a key topic or word and related words, phrases, and ideas. For example, suppose students are to create a concept map with the key word *transportation.* Related words could be the following: *vehicle, car, pathways, road, highway, street, streetlight, gasoline, tires, railroad, airplane, engine*, and *boat.*

The concept map a student develops would then be created by ranking the words. The most general word would be placed at the top. For example, the word *transportation,* which is the broadest and most inclusive word listed above, would be placed at the top of the page. Next, the remaining words or ideas would be arranged underneath in descending order until all words were used.

If more than three or four words can be placed under a word, then begin to look for another word that would encompass that word. There is usually an intermediate word that would address the extra words and thus create another level.

Connect the words, ideas, phrases, and concepts with lines. Words that help you follow how the words are connected or linked should then be added. For example, *transportation* would have *vehicle* linked to it, and the connecting phrase could be *requires a*. This linking phrase explains how a vehicle is part of transportation. Use of labels on the lines is essential in order to provide meaning and clarity to the student's thinking process. These labels will be used by the student and teacher to clarify understanding and to discover confusion.

The map should be reworked or modified as students continue to add to their knowledge, change their thinking, or discover another connection not previously made. This could become a yearlong procedure for students and can be a valuable tool to prepare students for various types of assessments, or it could be an actual assessment device. Teachers are cautioned to not use mapping as an assessment device until students have had ample time to develop understanding and have shown confidence in their use of the concept map.

Sample Concept Map

Using the words listed below, a concept map was developed. Students do not have to use all of the words, and they do not have to appear in any particular order.

Helping Students Develop Concept Maps

- Students should be encouraged to develop their own concept maps to guide them in understanding what they have learned.
- Encourage students to revisit their concept maps and revise them as new knowledge is acquired. Remind them that it is part of the learning process to change thinking and modify original ideas.
- Provide a handout that depicts the components of a concept map or have students refer to earlier samples.
- Assist students with writing and selecting appropriate words, phrases, or ideas for labels. Avoid giving them wording, but lead them to discover the links they want to make based on their own understanding and thinking.

Method 9-Standards-Based Student Assessment

Overview

When curriculum and instruction is based on *Standards for Technological Literacy*, students' understanding of their cognitive and procedural knowledge should be assessed by criteria derived from the content and meaning of the standards. This assessment process should be a collaborative effort, between students and teachers, so that the students will know ahead of time what will be expected of them and at what level of proficiency.

In the past, the result of activities (whether the project was successfully completed or not) was the goal of the assessment of students. How well students were able to complete a project, how effective or proficient they were at manipulating materials, or how well they would perform under pressure was the main form of assessment. In a standards-based activity, the goal is not just focused on the product of the activity. Rather, focus is equally given to the student's learning of the content that supports the development of the activity. The completion of the activity is still an important factor. However, equally, if not more important, is what the students understand about the content and how well they know how to do the necessary procedures.

The use of standards helps to focus the curriculum, helps to make expectations clear to students through consistency and cohesion, and, as a result, helps to improve the learning of students. The development of standards-based assessments should be based on existing units of study that are standards-based, include student interests, and provide for alternative means to examine student learning.

Preparing a standards-based assessment includes providing students with multiple means to display their work. Examples of student work may take various forms, but underlying them should be a clear picture of the standards that are being addressed and the methods that are used to address them. For example, assessment of a student is not limited to the end of the activity. You may want to embed assessment in the instruction to help guide decisions for future direction.

As a result, assessment is often taken informally to provide information on how well the student is moving toward attaining a standard. Taken as a whole, the assessment examples provide evidence of what students know and are able to do. Several sources of evidence are required to demonstrate that a student understands or has attained a standard. Therefore, multiple opportunities to explore a standard are necessary and helpful to students.

Definitions

Alternative Assessments: This type of assessment, synonymous with authentic- and performance-based assessment, requires students to actively accomplish significant tasks using the knowledge and skills learned. Examples of types of assessment are demonstrations, projects, written or oral reports, student interviews, portfolios, and self-assessments that are graded or evaluated.

Standards-Based Assessment: Student products and performances are assessed by using measurable objectives that relate to the overall desired content to be learned as identified in the standards.

Rubric (or Scoring Guide): Rubrics are a means to score the work of students that show detailed criteria for each level of accomplishment. It should be developed with student input so that they may develop an understanding of value-added learning. A rubric enables the teacher and student to know what is to be addressed and how it will be weighted.

Benefits of Standards-Based Assessment

- Provides specific targets and expectations for students to achieve.
- Allows students to learn how to evaluate their own projects and to be aware of their progress.
- Generates more information regarding how a student is progressing toward understanding the content than most traditional forms of assessment. These results can then be used to measure and show the student's progress and accomplishments.
- Uses a variety of means to communicate, such as multimedia, models, and simulations, in place of traditional question-and-answer form of a test.
- Encourages accountability of students and provides a means to demonstrate learning to parents, administrators, and the community.

Getting Started

1. Determine your goals for the activity and select the specific standard statements for which the activity will address. (Note: Near the end of each activity in Chapter 2, a list of criteria is presented to provide you with a guide to begin developing assessments.)
2. Determine what your students already understand and can do.
3. Based on the information in the first two steps, determine what is expected of students in meeting the standards addressed and how it will be incorporated into the assessment. In addition, determine how the completion of the activity will be used in the assessment process. (See scale, levels 1-4, in sample rubric as a guide.)
4. Write descriptors of the expectations that describe level of attainment from low to high accomplishment. These statements should be clearly stated and should be based upon facts and not the judgments of the teacher. Involve students in writing these descriptors in order that they may develop ownership of their learning.
5. Design the presentation of the activity and related curriculum activities that reflect the use of *Standards for Technological Literacy* and involves a variety of assessment techniques and methods.

6. Identify the alternative assessments that may be used, such as demonstrations, projects, written or oral reports, student interviews, portfolios, and self-assessment.
7. Prepare a rubric or scoring guide, checklist, or holistic statement for use in assessing the student's work. When developing a rubric or scoring guide, consider all aspects of the standards and allow for student innovation and creativity as they continue to learn the content. (See *an Example of a Rubric*.)
8. Collect examples of student work in order to maintain a record of achievement and to ensure consistency and visual clarity.

Assessing Learning in Problem-Solving

In a study conducted by Roger Hill, several mental processes were observed in order to record which were used by students involved in the study of technology. The following mental processes are indicators that students are learning to be problem solvers. These items can be used, along with traditional test and project grading, in order to assess student achievement.

Defining the Problem or Opportunity	Interpreting Data
Observing	Constructing Models and Prototypes
Analyzing	Experimenting
Visualizing	Testing
Computing	Designing
Communicating	Modeling
Measuring	Creating
Predicting	Managing
Questioning and Hypothesizing	

(Hill, R., 1997, p. 31-46).

For more information on assessment and problem solving, see Hill (1997). For more information about the relationship between assessment and standards, see *Standards for Technological Literacy* (ITEA, 2000).

An Example of a Rubric (Scoring Guide)

Rubrics are based on the identified criteria taken from the content standards. Points or words are assigned to each phrase or level of accomplishment. This method gives feedback to the students about their work in key categories, and it can be used to communicate student's performance to parents and administrators. The rubric example is designed to assess what and how well students understand the standards addressed in an activity.

Scale / Criteria From Standards	1 Beginning to Attain Standard	2 Nearly Attained Standard	3 Achieved Standard	4 Exceeded Standard
Design Brief Design Process	Suggested one idea and decided it was good. Did not interact with group.	Had two or three ideas but did not share or interact with the group.	Participated fully with the group and provided suggestions and varied ideas.	Participated fully with the group and helped others come to understand the process.
Identified Criteria and Constraints	Did not understand what was needed.	Provided a few constraints, but was confused when using the terminology.	Understood the terminology. Was able to contribute suggestions to the group.	Understood the terminology. Considered conditions outside of school and related them.
Design Fits Need	Ignored Criteria.	Used criteria haphazardly.	Incorporated all criteria.	Used all criteria, and modified the product to fit them.
Design Completed Using Constraints	Developed design without considering constraints.	Used most constraints, but was not sure why.	Appropriately used constraints and completed design.	Completed design using constraints efficiently and effectively.
Researched Space Life	Made up information.	Read textbooks, but wasn't sure of the information.	Researched using available resources. Compiled findings accurately.	Researched using resources and presented a formal presentation.
Used Model	Model was not made from sketch and did not use criteria or constraints.	Model incomplete. Used sketches.	Model resembles design and meets the design brief challenge.	Model clearly shows solution to problem, and extra care was taken to incorporate all aspects of the design brief.
Tested and Modified Model	Did not test model.	Model was tested. No follow-up action was taken.	Model was modified after testing.	Model was modified and tested until results were found. Presentation details the testing and modification.

Method 10-Engaging Community and Corporate Partnerships

Overview

Numerous local corporations are involved in tasks and enterprises that are related to the content being taught in technology education classes. Many of these corporations are interested in helping schools and young people through giving financial support, materials, time, and tools and sharing information. Teachers who seek these community and corporate partnerships enhance their classroom environment and broaden the educational experiences of their students.

Definitions

Community Partnerships
Community partnerships are often established by a middle school to encourage interaction between the students and teachers and the community as a whole. Through partnerships, schools are able to demonstrate how business and industry contribute to the community. Students learn about cooperation, are encouraged to participate in community activities and events, and discover the many resources available to them, such as libraries, museums, government agencies, and civic organizations.
Corporate Partnerships: A school or technology education department forms a partnership with a business or industry in the community in order to enhance the study of particular technologies or processes.

Resources a School May Give
Establishing a dialogue with a business or corporation helps in identifying the needs and interests of both parties and how the school may help in offering some type of help. For example, if a company wants to try out their new instruction manual, students could read and comment on its user-friendliness. Teachers may be able to train employees in human relations or problem-solving skills or teamwork. Keeping an open discussion between the school and corporate partners will help in determining ideas for a "give and take" relationship.

Resources a School May Receive
Frequently schools are able to request financial assistance from community and corporate partnerships. However, active partnerships can result in greater mutual benefits, such as guest speakers, volunteers, field trips, and donated supplies and equipment. Engineers, who volunteer their time in schools, are an effective addition to teaching technology. When time permits, personnel from corporations enjoy contributing their knowledge through presentations, demonstrations, simulations, or assisting teachers with developing curriculum and lesson plans.

Method 11-Using Modular Instruction

Overview
A clean, safe, and attractive laboratory-classroom is important to the learning process for students. However, the laboratory-classroom is secondary to the curriculum or content goals of the program of study. In other words, the curriculum should be the delivery method of the content and not the accomplishable in the laboratory-classroom provided. Most teachers are able to adapt existing facilities to the needs of students, while others are involved in the design, selection, and development of new instructional systems.

As the technological literacy standards are implemented, teachers will want to adapt their lessons and facilities in order to properly implement the ideas and vision. Modular systems are an effective method to use and help in school renewal. As with any method, teachers will be able to enhance the use of the modular systems through incorporating their experience in the development of dynamic and evolving units of study.

There are many benefits to modular instruction, such as:

- using a combination of multimedia instructional technologies (television/video, computers, textbooks, Internet);
- teaching a number of important concepts in a short period of time;
- introducing several career choices in the working world;
- encouraging cooperative learning, self-discipline with independent (self directed) learning; and illustrating applications of mathematics, science, social studies, and language arts through various activities.

Modular instruction is what we make of it. Each teacher needs to consider a basic module as just that, a basic. In order to be standards-based, a module will need to be adapted and modified to meet the needs of all students in the laboratory-classroom. Open-ended, problem-solving opportunities should be included. Modules that are written with a prescribed lesson should be investigated and adjusted to meet the needs of all students and the local guidelines and curriculum.

Definitions

Modeling Lab: This type of learning environment contains table top machines and a variety of tools and materials to promote the exploration, investigation and creation of a variety of products and systems. The modeling lab provides for individual or group learning activities. Support materials may be used, such as computers, multi-media, and textbooks.

Modular Lab: This type of learning environment uses modules to create learning centers throughout the technology education room. The module contains instructional equipment that delivers the content or lesson, generally to show students. The students learn and work through the use of a booklet or a computer. Support material is provided through watching video, reading textbooks, and building a project using appropriate tools, machines, and materials as identified in each module.

Combination Modeling and Modular Lab: This type of learning environment combines the modeling and modular labs into one laboratory-classroom. Students work in a variety of settings from prescribed modules in pairs to group projects developed by the student using a combination of modules and equipment. Students are able to move from identified learning goals to free exploration and development of products and systems. Opportunities for learning about inventions and innovations provide open-ended problem-solving experiences.

Getting Started Using Modular Instruction

Due the variety of modular packages available, the recommendations are written to give teachers a starting point in helping them make modules standards-based. Teachers are advised to consider the needs of their students, the local curriculum, and the type of module system and facilities available in making adjustments to modules. In addition, it is recommended that teachers consider making small changes. Some modular packages that come with a CD-ROM version of the curriculum allow teachers to edit and make adjustments. Teachers should use the instruction provided in the modules as a beginning and gradually add suggested methods to enhance each module. The following

suggestions are to be used as a guide and not intended to be the only correct means to implement *Standards for Technological Literacy.*

Modifying a Module:

1. Read and become familiar with *Standards for Technological Literacy* and the methods suggested in this guide.
2. Read through the notebook or lab manual provided for each student or pair of students. Make notes on specific pedagogy or practices that are missing from the module. For example, if students are expected to read about bridges in a modular library before they may begin their design activity, add the component of an Internet or CD-ROM search to the library search. Provide specific questions students should be addressing when doing their research, such as:
    a) When was the bridge first developed?
    b) Why was the bridge developed?
    c) Who does it help? Where is it used?
    d) Was a particular skill or ability needed to help in the development of the bridge?
    e) What important design ideas were necessary to help the bridge stand and function properly?
    f) What particular geometric shapes are most often used in bridge design? Why do you think this is so?

    Choose a particular bridge to research to answer these questions:
    g) If this bridge has a name, what is it?
    h) Where is it located? When was it erected?
    i) Who designed/engineered this bridge?
    j) What was happening in history when this bridge was developed?
    k) How has the bridge changed over time?
    l) What benefits or changes came as result of this new bridge?
3. Decide what methods you may add to your module that will enhance and help you implement *Standards for Technological Literacy.* The focus is on helping students think about their learning and to develop ownership in their knowledge of technology through their active learning. For example:
    - *Method 1: Using Design Briefs to Challenge Problem Solvers* may be added to the specifications page provided in the module. Teachers may use the *Template for Design Brief* on page 12 or design their own design brief layout.
    - *Method 2: Teaching Students to Assess the Impact of Technology* may be added at the end of a module activity as part of the completion of the module or as an extension. Students are given an opportunity to reflect on their knowledge of technology and its relation to their own world.
    - *Method 6: Sharing, Reporting, and Recording Information* is easily added to the documentation that students are required to do in many modular packages. Using the reporting as a means of assessment at the end of a module will allow students to demonstrate their knowledge and meet strict deadlines.
    - *Method 8: Using Concept Maps* ™ *to Facilitate Learning* may be used as a pre- and post-test assessment as well as used throughout the module to

reinforce students development of vocabulary and vocabulary relationships with the processes the students are learning.

- *Method 9: Standards-Based Student Assessment* allows students to be a part of their own learning in determining what is important for them to know. Many modules already have questions or sections allocated for assessment. Providing opportunities for students to develop rubrics or determine what is acceptable helps them identify their level of success and empowers them to develop strong problem-solving and critical thinking techniques.

4. Gradually implement your changes making notes about what worked smoothly, what still needs to be modified, and what other adjustments you may still be able to make. Consider all possibilities and continually refer to *Standards for Technological Literacy* and this guide. Most importantly, remember that change takes time and making adjustments to modules should be done with care.

Using Modules to Their Fullest Potential

Modular instruction has the potential for every pair of students to be learning different content, doing different activities, and solving different problems with little interaction with other students. The following suggestions allow students to expand their learning opportunities and to experience different dimensions of their learning while sharing their ideas and thoughts:

1. Let students talk to the class about their particular solution to project. Provide a display area where students may place their creative thinking.
2. Develop a culminating activity that will utilize the learning of two, three, or more modules so that students combine their efforts into a group project.
3. After students have completed several modules allow them to select one for more intensive study. Include several methods mentioned in this guide that provide guidance and directed learning.